EFFICIENCY IN HIGHWAY ADMINISTRATION WITH SPECIAL REFERENCE TO PAVEMENTS

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The application of scientific methods of management to a department of highways is not a new problem. Until very recent years, however, definite results derived from such a type of administration have been practically unknown. The men who have been placed in charge of the streets and highways have often been grossly incompetent and in some cases dishonest. More often absolutely ignorant aldermen and other city administrators retained the decision covering all such matters for ulterior motives not hard to guess. The necessity for a remedy and the remedy itself for such conditions are so apparent that dishonesty is now rapidly being supplanted by integrity and incapacity by at least a desire to learn. Even in the routine inspection the excessive amount of technical detail involved in the proper maintenance of pavements makes it imperative that the administrator be not only an engineer but also one who can appreciate the value of systematic reports and records. That is, he should be an efficiency engineer. How to make scientific efficiency result from the good intentions of the highway administration is the problem to be discussed.

For every engineer of highways or commissioner of public works there are two main problems in connection with the maintenance of pavements: first, the original pavement—its selection and construction, with the attending financial problems; second, the maintenance of the pavement after it has been accepted from the contractor, with the accompanying difficulties of tax budget appropriations to cover maintenance and inspection costs, and the very important question of the proper time to repave. Of these two, the maintenance proposition offers the more serious difficulty, but in order to follow the actual time sequence the original contract will be considered first.

Independent of whether the pavement to be constructed is a complete repaving or whether it is an original construction, the questions which should come to the mind of the highway administrator are identical so far as the selection of the kind of pavement is concerned. What is the traffic—how much, what kind, what percentage is horse drawn, what percentage is motor? What is the street grade? What is the character of the street—residential, tenement, manufacturing, shopping, occupancy by car lines? What has been the history of the street and what is its probable future? Finally, how much money is available? The question of the capital outlay should be made a point of minor consideration, not that the expenditure of money is of no consequence, but too close economy on the original financial side of pavement selection is in the end likely to result in no economy. Unfortunately, this statement can be impressed on the average taxpayer only with the greatest difficulty. It has been proved too often, however, in too many cities, to admit of more than a reasonable doubt.

With traffic records as a basis and a decision made as to the intended use of the street, whether for a boulevard or for general trucking, etc., the administrator must next select the general class of pavement which will satisfy his conditions. For heavy traffic on grades, a form of stone block; for the same kind of traffic on a more nearly level street, wood block; for lighter traffic in the residential district, a form of asphalt; for still lighter traffic on a park boulevard, a bituminous macadam.

A point of supreme importance which can be considered here only in the most general way, but must never be overlooked, is the preparation of proper specifications. Recently, attempts have been made by the government and by associations of engineers to unify and codify the experience of all highway engineers throughout the country and make it available for others, in the form of standard specifications. It is indeed a weak minded and narrow administrator who will rely solely upon his personal experience or the experience of his own city, in such matters; for by taking advantage of the mistakes and the successes of other municipalities, every city can be kept at the forefront. This is more nearly true in regard to specifications than to any other side of the pavement problem. Specifications prepared by associations of engineers whose integrity cannot be questioned are at the disposal of every highway department in the

country. It was an unhappy situation that, for some time, national highway associations and other municipal engineering societies often had behind their organization an ulterior motive. As a consequence small reliance could be placed upon their recommendations. But the advancing standard of the individuals who make up these organizations has materially raised the standard of the organizations as a whole, making them now invaluable to every highway engineer.

The contract and the specifications must be thoroughly understood by both the contractor and the contracting party, and the proposal for bids must be comprehensive. The courts in nearly every state demand this. Having once established a thorough understanding between the city and the contractor, specifications should be enforced to the letter. It is the right of every taxpayer to know that the specifications offered with the proposal for bids are being followed, and that the city is paying for no more and no less than what was asked for at the public hearing.

Preceding the payment of money comes the raising of money, which is variously accomplished by assessment, bond issue or tax levy. The financial problem in the construction of a pavement depends upon the conditions under which the pavement is being laid—whether the street is being improved for the first time or is being repaved, and what kind of pavement constitutes the improvement.

On original construction work the custom has usually been to assess the cost on the property benefited, but the proper distribution of an assessment is extremely complicated. In a purely residential district, where traffic is almost solely for the direct benefit of the adjoining property, an assessment of the whole cost of the improvement can be levied upon the abutting property without grave injustice. When, however, it comes to assessing upon the adjoining property the cost of a wide boulevard which will be used by the whole community, the injustice is obvious. Various compromises are effected in the different communities. Perhaps the most equitable one is to charge the abutting property with an arbitrary amount roughly corresponding to the cost of one serviceable pavement for a street of average residential width, allowing the property owner to make payment in as many as ten installments, if he so elects; such money to be credited to a paving fund originated by a bond issue for a term not greater than the extent of the deferred payments.

A number of states require that the assessment for any sort of public improvement shall not be greater than the actual increment derived by the property. This is, no doubt, an ideal theory, but just how to determine the exact benefit from public improvements is a question which has never been solved satisfactorily. In addition, the procedure offers many opportunities for injustice and dishonesty.

There are, however, two real objects in levying an assessment: (1) to distribute the cost of the improvement against the property benefited, and (2) to prevent automatically the laying of new and expensive pavements in absurd locations throughout the city. Consequently, even though assessments are often unfair to the individual, the city cannot afford to lose that protection. If but one assessment for paving is to be levied against each piece of property, even if the pavements on different streets are not identical, care must be taken in the preparation of the administrative code to insure that they shall be of one general class both as to wearing qualities and cost.

Repaving, particularly in the larger cities, cannot usually be considered a proper assessment charge. Neither is it a strictly proper item for the annual budget, owing to irregular expenditures. Under ideal administrative conditions, wherein equitable sums would be expended for repaving each year, the use of tax levy funds certainly would be justified. The scheme, however, is not compatible with the present policy of frequent administrative changes and the lack of standard pavement conditions. This difficulty could be largely overcome by the development of a detailed and studied plan for future paving work. When such a plan has been prepared, the lack of steady tenure in office by the chief administrator will not seriously affect the working out, if the following of the plan be made an invariable departmental policy. The failure of most cities to definitely outline future work indicates, for the present, the propriety of a bond issue. But while this may be the best method when properly conducted, it must be confessed that the issuing of bonds has often been a source of trouble.

In many cases enormous amounts of money for pavements have been unfairly distributed in the tax levy, owing to poor methods of financing bond issues. The tendency has been to issue bonds extending for a term much longer than the life of the pavement. Thus the community was called upon to issue additional bonds for repaving while still paying interest and sinking fund charges on a

dead pavement. Such a condition has been repeated as many as four times, the wear and tear being so heavy that repaving was often required before the original bonds were redeemed. Fifty year bonds have not been exceptional. The taxpayer was, therefore, carrying a yearly financial burden to which had to be added all of the actual maintenance cost. The cure is obvious—when bonds are issued the term should not exceed the life of the pavement.

A study of the situation seems to warrant the use of a ten year bond—a ten year serial bond, if possible. This may be too short a period for the smaller cities, but for the larger cities where the traffic is heavier and the wear and tear more rapid, the ten year period would surely be a step in the right direction. It must not be understood from this statement that pavements on an average do not last more than ten years. That, of course, is not true. But in the last few years of the life of a pavement the increasing cost of maintenance and the decreasing usefulness of the pavement make it unfair to distribute an equitable share of the original cost to the taxpayers of those years.

When patent pavements first came into general use, owing to the uncertainty in the minds of everyone as to their reliability, the cities in nearly every case required a long term guarantee from the contractor—a term which in some of the larger cities was longer than the average life of the pavement. Of course, this was absurd, and, in consequence, numberless abandoned contracts were thrown back on the municipality, and many paving companies went into bankruptcy. Then for a time, the attitude seemed to be that there should be no guarantee. This was probably a reaction too far in the opposite direction. Ideal specifications and inspection and the assurance of unquestioned integrity on the part of both the contractor and the contracting party would eliminate all necessity for any guarantee, but such ideal conditions are not yet attainable and, for that reason, it does not seem advisable at the present time to eliminate a guarantee entirely. Five years is long enough; probably a shorter guaranty period would be better.

The maintenance problem is one of detail, and on that account has become irksome to many an administrator, who prefers rather to deal with big figures and large items. Thus the control of maintenance has usually been relegated to subordinates who either did not know or did not care sufficiently about highway efficiency to

conserve the interests of the community. With the possible exception of the financing of paving work, which has already been discussed, more money has been wasted in maintenance than in any other division of highways. Maintenance combines the question of inspection and repair, embracing the wear and tear caused by traffic, cave-ins, public service corporations, departmental cuts, etc. It has to do with all kinds of pavements, and involves the question of whether repairs should be made by city gangs or by contract with paving companies.

The first step towards efficiency in maintenance is the installation of a comprehensive system of inspection. Of course there must be an assurance of accurate and honest inspection of workmanship in the original pavement and in all restored areas, but a basis for the location of repair gangs is equally essential. Such reports can be secured only from a system which will show the exact conditions existing at a definite date together with the history down to that point.

Preliminary inspection is a question of patrol of a given district. How many inspections are needed and how much ground an inspector can cover in one day are entirely questions of locality, of traffic, etc., and must be decided by each city for itself with direct regard to the district in question. There is no reason why the preliminary or patrol inspection of the streets should not be amalgamated with the patrol inspections of the other departments of public works. By decreasing the mileage which an inspector is forced to cover in a given period of time—at the same time increasing the scope of his duties by requiring not only reports on the condition of the streets but also on encumbrances, street signs, defective lights, etc.,—it will be possible to obtain more work per mile without additional effort and without imposing any hardship on the inspector. Greater diversity of reports will produce greater interest in his work and result in higher efficiency.

It is usually considered necessary to make a very clear distinction between the reports of wear and tear, and the reports of cuts, damage done from new buildings, cave-ins, etc. The reason for this is obvious from a financial standpoint. Wear and tear repairs are strictly a tax budget item, while repairs of cuts and other damaged areas, which have arisen by the specific act of the individual working under a permit or the like, are not so directly chargeable to the general

taxpayer. Such repairs should be paid for out of a special or trust fund made up from the deposits required on special permits issued to cover every damaging use of the highway.

Just how detailed a report should be required of the patrol inspector for wear and tear defects is largely a question of the condition of the pavement, or rather, what standard has been reached or is expected to be reached in the near future throughout the city. On great engineering construction work a most detailed inspection is required, but, unless the pavements have reached such a high standard that a wear and tear defect is an exception rather than a general rule, it would be cumbersome to require an individual report on every wear and tear defect every day it remains unrepaired. By properly educating the gang inspector to report explicitly the nature of the repair as well as the size of repair, the necessity for an itemized segregation of items in the preliminary reports is certainly not necessary.

To facilitate the routine office procedure, the preliminary inspection of each cut can be profitably reported upon an individual form. But it must not be forgotten in this connection that the less writing in the field the more work it is possible for the inspector to do. It is highly advisable to send from the office to the inspector a form filled out with as much information as possible and thus facilitate his work. He should be required merely to state that the rules and regulations of the department are not being violated in each instance, and to report the area and location of the cut. By making out this form in duplicate in the main office and retaining one copy, it is possible to set up a very simple "tickler" of the incoming reports of the patrol inspectors. To the above should be added enough supervision by reliable men to assure the official in charge that the reports of the inspectors are accurate and the outline of the system for preliminary inspection is complete. A certain amount of leeway must be provided for the reporting of fire-burns, cave-ins and areas damaged from unknown causes, also for the reporting of miscellaneous violations of the department's regulations, all of which are original inspections initiated in the field.

The next question is how to make use of the information contained in the reports from the patrol inspectors without establishing a routine so cumbersome that the overhead charges of the department become top-heavy. The first step is a system of accurate filing,

preferably by blocks and intersections, in turn grouped by contracts. A display map showing the locations of the gangs, and, by some simple means, the amount of yardage to be repaired within a given block, will prove of great assistance. For cuts and the like which are usually repaired on individual orders, a simple "tickler" file set to throw out all cuts remaining unrepaired at the end of the time limit specified in the contract will give information upon which to enforce the liquidated damage clause for such delay. If consistently followed, this process will assure prompt repairing in the majority of cases.

In formulating a system for inspection of the laying of pavements, particularly repair work, the assurance of adequate inspection at the paving plant is imperative. Good results never can be obtained from poor raw material, but the best possible material can be made useless by improper handling at the plant. These plant inspectors should be men with scientific training and could well be placed in close connection with the chemical laboratory.

This applies fully as much to a municipal paving plant as to that of a private corporation. In the smaller cities where it is not possible to obtain the continuous service of a paving company it is a great advantage for the municipality to establish its own repair plant in a small way. It has also been found from the experience of larger cities that it is possible to obtain good results from city repair gangs where those gangs were engaged on work not requiring highly technical employees or not involving special materials, the handling of which had to be left to technical men.

Inspection of repairs is a question of training the inspector. The absolute necessity for accurate reports both as to workmanship and measurements emphasizes the need for securing men whose honesty cannot be questioned. This latter question is no doubt a difficult one, but competent supervision will overcome it to a large extent. Some of the large public service corporations that deal directly with the paving companies in restoring cuts, etc., require that the reports of area restored shall be signed not only by their own inspector but also by the foreman of the paving company. This is a suggestion which need not be applied to municipal work if the contract between the city and the contractor provides that the city may at any time give direct orders, through its representatives, regarding repair work and may demand the dismissal of any foreman who is either

inefficient or dishonest. Next must follow the assurance that the reports received from the gang inspectors are accurate.

In connection with the training of a competent inspection force efficiency talks by the engineers of the department, explanations of specifications, the preparation of a comprehensive book of instructions prepared in such a manner that it can be easily understood by the inspectors, and all other such helps, are invaluable. Owing to the peculiar nature of the work, specifications for paving materials are of necessity complicated, and those for workmanship are broad and comprehensive, but lacking in detail. It is not possible to avoid entirely this complexity, but by proper instruction and by careful supervision it is quite possible to overcome the uncertainty in the non-technical minds of the usual type of inspectors, and foremen of paving gangs, as to just what is to be required of them.

Reports of areas restored can be very simple. All that is necessary is the location of the patch and a statement of the dimensions. Patches are often irregular, of course, and these dimensions must be taken from the nearest measurable figure. It is not advisable to have the extensions of areas calculated in the field. Greater accuracy at less expense can be obtained from clerks in the main office who know how to add and subtract and multiply, but who do not know the difference between good asphalt and poor concrete. Here again adequate supervision is imperative. The marking out of the areas to be restored and the reporting of the areas as restored should be made by the inspector who is with the gang. Some check over the economy in the distribution of repairs can be made by comparing the preliminary reports of the patrol inspectors as to area with the final reports of the gang inspectors. This, however, is not complete. Sometimes, considerable time will elapse between the preliminary report and the repairing of the defective area by the gangs, and just how much increase in defective area should be allowed for the given time can never be accurately estimated.

Whether or not to require a guarantee of the patches laid under a maintenance contract which has a life of but a single year has been a question considerably discussed of late. In order to enforce a guarantee it is necessary to plot the repairs made and to deduct overlapping areas laid during the course of the contract. Unless selected streets only be plotted, the plotting of repairs necessitates an enormous amount of drafting work, from which there is a considerable

question of any return on the investment. The net economy of this plotting work in the last two years on some of the most heavily traveled streets of New York has been less than five per cent, and if the general overhead charges were added to the cost of the plotting there is grave doubt whether the city would in any way be the gainer. Adequate inspection of material and workmanship and honest measurement really void the necessity of any guarantee period in a strictly maintenance contract.

One of the greatest difficulties in all cities is the lack of interest among the employees in the work they are asked to do. This is a general proposition and affects highways no more or no less than a number of other city departments. It is always a serious obstacle in the way of efficiency. Inspectors, who are usually in the $900 to $1,500 class of city employees, are not high grade men. The civil service lists are crowded with men looking for outside work with nothing more to recommend them than that they passed in some way some sort of an examination. How to overcome this difficulty is indeed a question. No one so far has been able to solve it completely, but the greatest step taken toward its elimination has been the establishment of efficiency records—records which the inspector should be given to understand will be used as a basis for promotion or discharge, something which they will be assured will be a public record of what they have done, and can be made either their best friend or their worst enemy. It is an incentive to work and an assurance that honest efforts will be rewarded. There are just as many ways to tempt a man to do right as to tempt him to do wrong, and the efficiency record is a chance to make good and to go on record as having done so.

Considerable success has been attained by different cities in making their own pavement repairs, including repairs to stone block pavement, telford, macadam and a great number of variations of a mineral aggregate with an oil binder, together with the well known sheet asphalt. In connection with either a municipal repair plant or repair gangs, the necessity for a comprehensive cost system cannot be overestimated. The materials saved in the course of the year will more than pay for the cost of running the system, while the friendly rivalry excited among the foremen of the different gangs is an incentive toward better work and more of it. Several such cost systems are in active operation and the results obtained are gratifying.

In connection with costs and with the payment of contracts, comes up the invariable question of how and where to get the money. Maintenance of pavements is surely a tax budget item and as such should be included in the estimate for the budget made up by the department. How to estimate the amount of money needed for repairs in the coming year is somewhat of a question, and the ideal method has by no means been reached. It is always possible, however, to set up for the different kinds of pavements the unit costs of maintenance per square yard of actual pavement laid, and it is also possible to find out the total square yards of pavement which have been under maintenance for the year. In order to make a comprehensive statement of the moneys needed for the coming year it is necessary to know two things: first the yardage which will come out of guarantee during the next year, and second, how much old yardage will be substituted by new pavements. Usually the termination of the guarantees are distributed throughout the year with the exception of December, January and February, and, if so, it will not be far wrong to divide the total coming out of guarantee by two in order to arrive at an average maintenance area on expiring guarantees, calculated on a whole year's maintenance basis. The same question of average applies with regard to the area which is to be newly repaved, if the repaving contracts are distributed equally throughout the year. It is then possible to estimate the amount of money required for the following year based on the average or unit cost per square yard for the previous year, applied to the yardage of that year, increased by the first of the two items mentioned and diminished by the second one. If the unit cost be high, the estimated amount for the following year will be correspondingly high. If the condition of the pavements at the end of the year be poor and it is intended that in the following year the conditions shall be brought up to standard, then either more money or greater efficiency of work is necessary, or perhaps both.

The study of the relationship between the repairing and the repaving of worn streets is, when considered scientifically, a decidedly new field. There are so many factors affecting the decision, that attempts to arrive at a scientific formula for such determination have not been wholly successful. It has always been the custom for the highway administrator to guess indifferently, or yield to pressure of one kind or another whenever it was deemed necessary to repave

any street. To obtain any basis for the application of a general rule to a particular street it is essential that the actual or estimated cost of maintenance be the cost necessary to put the street in the condition standard for that city. To set up an arbitrary rate for maintenance cost, per square yard of existing pavement, which must not be exceeded in a single year; or to limit the expenditure for maintenance each year to a definite percentage of the original cost of the pavement; or to delay repaving until the total of the average yearly maintenance added to a yearly sinking fund charge toward a depreciation fund, is at a minimum: all are methods depending for successful operation on a continuity of policy and standard pavement conditions. Until such perfection is reached, however, the ultimate basis for decision must be the judgment of the administrator.

The installation of a procedure in highways departments which will develop efficiency in the administration is a problem which involves to a considerable extent the local conditions. But the general outline and underlying principles are the same throughout the country: controlled inspection; standard specifications and contracts; proper use of assessment, tax levy, and bond funds; traffic records and their interpretation; comprehensive reports with intelligent summaries; efficiency and cost records; and, finally, the selection of an administrator technically trained, not as an engineer alone, but, rather, as an efficiency engineer.

Technically speaking, highway engineering is not complex but add to the engineering difficulties the great amount of detail involved, and the difficulties in the way of definite organization and control are quite apparent. They are not so great, however, but that any municipality by making the necessary changes in organization, both as to procedure and personnel, could obtain definite results in a period short enough to be well within the term of one administration. By taking advantage of the results obtained in other cities this can be accomplished. Highway efficiency is anything but the intangible fantasy of a theorist. It is a real live principle with a history filled with many failures, but also with many successes, all of which have taught their lesson in developing efficient administration.